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WORKSHOP ON TECHNOLOGY ISSUES IN FREE-SPACE OPTICAL PROCESSING

Salt Lake City, Utah,
March 4, 1989

MEETING NOTES

1. Devices and Nonlinear Materials

General

Digital device designers want small fan-in and fan-out. Architects would like the flexibility of large fan-in and fan-out.

Do we want a generic technology for all applications and architectures?

Integration and technology re-use are important.

Need to have broadly-based teams to make an impact.

Importance of meaningful communication between device and architecture people.

Important to discourage architects from resorting, in desperation, to the wrong technologies.

Opto-Electronic Devices

What drive voltage can we tolerate in optically- connected electronics?

Integration of conventional lasers with electronics is not a solution for large free space systems.

Memory technology is still an issue for large opto-electronics.

Need to motivate a major technology effort to implement the necessary optoelectronic devices.

Devices for Neural Computing

Neural computing - requires a large dynamic range.

Do we even want analog devices for neural processors because of flexibility issue?

Neural networks may need optoelectronics for functionality.

Physical Issues

Temperature tability required for operation of device.

In resonator enhanced devices with quantum wells
(i) may be a lateral mode problem for small devices.
(ii) may be a growth tolerance problem for such resonators.

Threshold variations are very important for devices that are to be used in very large numbers.
e.g. liquid crystals
nonlinear Fabry-Perot devices

Materials Issues

What will be the uses of nonlinear optical materials such as organics?

Still material issues with photorefractives - too high power.

Will need to design materials to suit sources.

2. Optical Sources

Two-Dimensional Laser Arrays

Can we make small efficient surface emitting lasers?

Are two-dimensional arrays of lasers practical devices for free-space applications?

Vertical cavity, lower power lasers are a fundamental research area.

There may be fundamental issues with statistics in very small laser devices, more so than in electronics.

Two dimensional arrays are at an earlier stage of development than high power lasers.

Individual addressing of array lasers may have problems.

High-Power Laser Diodes

There are thermal uniformity problems in high power laser arrays.

Lifetime on high power lasers is still an issue, possibly serious.

We will only use diodes or diode-pumped systems for any near-infrared wavelength systems.

There are some possibilities for short wavelength systems by doubling.

General

Do devices run at correct wavelength to suit lasers?

Is a pulsed or a c.w. system desirable?

Is pulsed operation possible?

3. Optical Systems

What optical systems do we need for optically-interconnected electronics?

Photorefractives for interconnect;
(i) do they have enough dynamic range?
(ii) are they fast enough?

Systems loss budgets - what is realistic?

Must avoid 1/N fan-out loss.

Will aberrations be a problem?

Can we handle polarization components and effects in practice?

What are the resolution requirements for computer generated holograms?

We want small devices for high speed and lateral density. Can we align the resulting system?

Volume density of optics- F/1 optics use too much vertical space.

Tolerance to hostile environments - vibration, smoke.

Security

Reliability

All components fabricated by photolithography?

4. Architectures

Memory

Memory - what is needed and how should it be accessed?

Memory hierarchy same as digital computers

Cache
Primary
Secondary

Devices

Cost of photons vs. electrons in detection.

Optical CMOS; can optical gates be used in an energy effective manner?

Optimum size of electronic "island" for optical interconnects?

Match algorithms with machine or machine with algorithms?

How will the architecture scale?

Size of components vs size of interconnection pads.

Design limitations for arrays - is (10 x 10) → (100 x 100) reasonable?

Interconnections

Interconnection hierarchy.

Are programmable interconnects necessary?

Global random interconnections - are they possible and/or desirable with optics?

New algorithms for non-regular interconnects.

Reconfiguration of connections for minimum energy usage.

Control and routing issues may change free-space

interconnections requirements

How many interconnects/unit time vs. energy and noise requirements.

General

Do our architectures need large fan-in and fan-out?

Architectures may need to be tolerant of device failure.

What error rate is acceptable for what architectures?

Do we need data, programs and control in the same format?

Are input and output the key advantages of optics?

Parallel vs. serial architectures.

Number of lenses for architecture?

Match algorithms with machine or machine with algorithms?

How will the architecture scale?